

6 Draw and label the following angles:

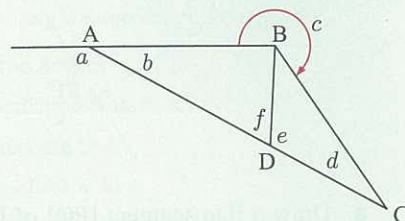
- a reflex \widehat{BAC} b acute \widehat{PQR} c obtuse \widehat{TRS}

7 a Find the angle corresponding to:

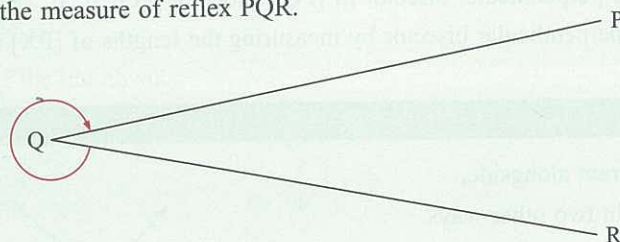
- i \widehat{BDA} ii \widehat{DCB} iii \widehat{BAC}

b Classify the following angles as acute, obtuse, or reflex:

- i c ii a iii d

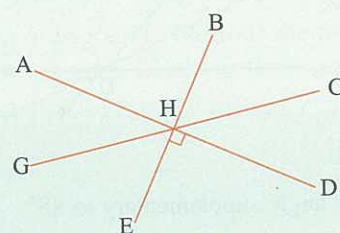


8 a Determine the measure of reflex \widehat{PQR} .



b Find, without using a protractor, the measure of acute \widehat{PQR} . Justify your answer.

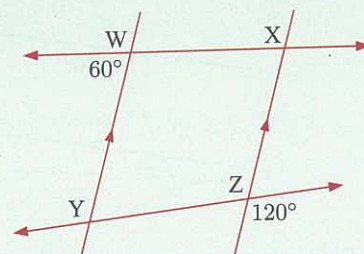
9



Classify the following angles as complementary, supplementary, or neither:

- a \widehat{CHA} and \widehat{CHD}
b \widehat{AHG} and \widehat{AHB}
c \widehat{BHC} and \widehat{CHD}
d \widehat{BHC} and \widehat{EHG}

10 Decide if (WX) is parallel to (YZ) , giving reasons for your answer.



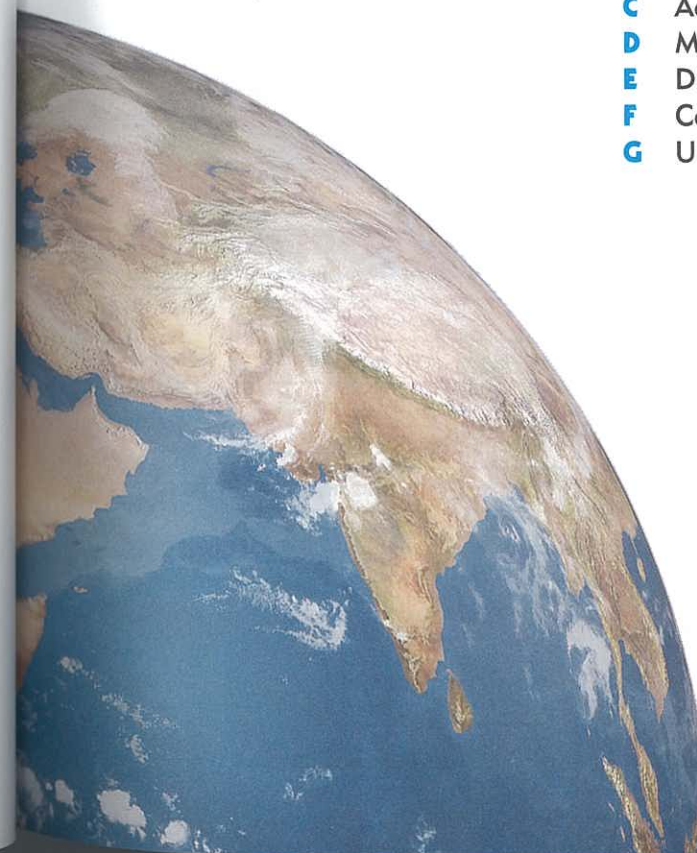
Chapter

3

Positive and negative numbers

Contents:

- A Opposites
- B The number line
- C Adding and subtracting negatives
- D Multiplying negative numbers
- E Dividing negative numbers
- F Combined operations
- G Using your calculator



OPENING PROBLEM

Credit cards are a common way to pay for things. When you buy something, its value is *subtracted* from the card balance. When you make payments onto the card, the amount is *added* to the card balance.

Things to think about:

- Graham's credit card has a balance of $-\$1230$. He purchases a table for $\$799$ using his card. What will his new balance be?
- Jill's credit card has a balance of $-\$271$. She pays some money onto the card, and her balance now reads $+\$105$. How much money did Jill put on the card?
- Kate buys $\$75$ worth of groceries each week using her credit card. If her starting balance is $-\$330$, what will her balance be after 5 weeks?



The **natural numbers** 0, 1, 2, 3, 4, 5, ... are useful for solving many mathematical problems. However, there are certain situations where these numbers are not sufficient.

You are probably familiar with the **countdown** for a rocket:
10, 9, 8, 7, 6, 5, 4, 3, 2, 1, BLAST OFF!

But if we keep counting backwards, what comes after zero?

It may seem that we have 'run out' of numbers when we reach zero. However, there are many situations where we need to be able to keep counting and where an answer of less than zero has a sensible meaning.

For example, which of these ideas can you explain, either in words or with a diagram?

- 10 metres below sea level
- owing $\$30$
- 5 degrees below freezing
- 3 floors below ground level



A

OPPOSITES

Many mathematical problems involve **opposites**.

These include:

- having money in a bank account and *owing* money to a bank account
- temperature *above* zero and temperature *below* zero
- height *above* sea level and height *below* sea level
- putting purchases on a credit card and paying off the credit card debt.

DISCUSSION

Prepare a list of *ten* opposites which involve numbers.

Instead of using words to distinguish between opposites, we can use **positive** and **negative** numbers.

POSITIVE NUMBERS

Positive numbers are numbers which are greater than zero.

They can be written with a **positive sign** (+) before the number, but we normally see them with no sign at all and we *assume* the number is positive.

- For instance:
- '10 metres above sea level' would be written as $+10$ or just 10
 - 'having $\$30$ ' would be written as $+30$
 - '3 floors above ground level' would be written as $+3$.

In each case a measurement is being taken from a reference position of zero such as sea level or ground level.

NEGATIVE NUMBERS

Negative numbers are numbers which are less than zero. They are written with a **negative sign** (−) before the number.

- For instance:
- '10 metres below sea level' would be written as -10
 - 'owing $\$30$ ' would be written as -30
 - '3 floors below ground level' would be written as -3 .

Again, the measurement is being taken from a reference position of zero.

Some common uses of positive and negative signs are listed in the table below:

Positive (+)	Negative (−)	Positive (+)	Negative (−)
above	below	fast	slow
increase	decrease	win	lose
profit	loss	north	south
right	left	east	west

We say that positive and negative are **opposites**.



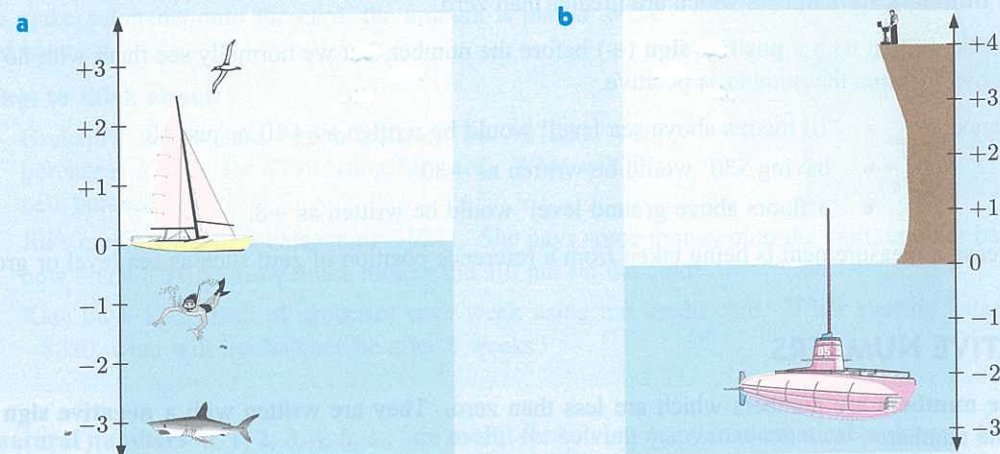
EXERCISE 3A

- 1 Copy and complete the following table:

	Statement	Number	Opposite of statement	Number
a	winning by 5 goals	$+5$		
b	25 m east of a building			
c	a clock is 3 min slow			
d	a gain of 4 kg			
e	a loss of $\$1250$			
f	20 km south of the city			
g	200 m above sea level			
h	11°C below zero			
i	a decrease of $\$100$			
j	one floor above ground level			

Example 1**Self Tutor**

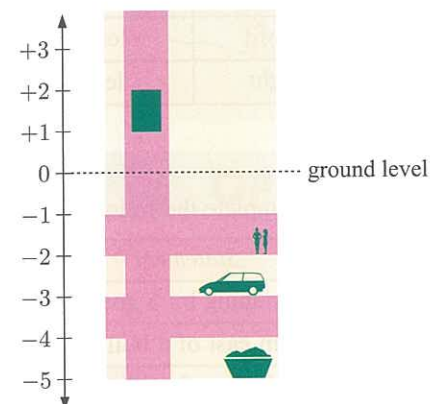
Write the positive or negative number for the position of each object.
The reference position is the water level.



- a** Positions *above* the water level are marked with *positive numbers*.
 \therefore the bird is at +3.
 The boat is level with the water, so it is at 0.
 Positions *below* the water level are marked with *negative numbers*.
 \therefore the diver is at -1 and the shark is at -3.
- b** The clifftop is at +4, the top of the periscope is at +1, the water level is at 0, and the submarine is at -2.

- 2** Write positive or negative numbers for the position of each object. Use the bottom of each object to make your measurement.

- a** lift
b car
c people
d rubbish skip



- 3** With zero as the reference position, right is positive and left is negative. Write numbers for the positions of A, B, C, D, and E.



- 4** Write these temperatures as positive or negative numbers:

- a** 4°C below zero **b** 21°C above zero **c** 13°C above zero
d 17°C below zero **e** 32°C above zero

- 5** If north is the positive direction, write these positions as positive or negative numbers:

- a** 3 km south **b** 15 km north **c** 250 km south
d 2000 km south **e** 57 km north

- 6** State the combined effect of:

- a** a withdrawal of \$70 followed by a deposit of \$100
b a rise in temperature of 2°C followed by a fall of 5°C
c a 4 km trip east followed by a 3 km trip west
d 9 steps south followed by 9 steps north
e going up 8 floors in a lift then coming down 9 floors
f a loss of 6 kg followed by a gain of 4 kg.

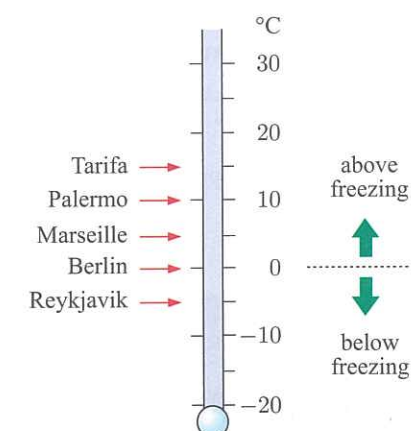
- 7** A baby girl weighed 3270 grams at birth. The record of her weight for the first five days is shown opposite.

- a** Write each day's gain or loss as a positive or negative number.
b What was the baby's weight at the end of the five days?

Day 1:	56 g gain
Day 2:	16 g loss
Day 3:	28 g loss
Day 4:	73 g gain
Day 5:	19 g loss

- 8** The minimum temperatures of some European cities were recorded on December 1st. The results are shown on the thermometer.

- a** What was the temperature for each city?
b How many $^{\circ}\text{C}$ was Tarifa warmer than:
i Palermo **ii** Berlin **iii** Reykjavik?
c How many $^{\circ}\text{C}$ was Reykjavik cooler than:
i Berlin **ii** Marseille **iii** Palermo?
d What was the difference in temperature between:
i Berlin and Palermo
ii Marseille and Tarifa?

**B****THE NUMBER LINE**

We can represent all whole numbers on a **number line**. This line extends forever in both directions.



The numbers to the **right of zero** are the **positive** numbers.
 The numbers to the **left of zero** are the **negative** numbers.

The negative whole numbers, zero, and the positive whole numbers are together known as **integers**.

Pairs of numbers like -7 and 7 are exactly the same distance from 0 but on opposite sides of zero. They are therefore called **opposites**.

Zero is neither positive nor negative.



Example 2**Self Tutor**

What is the opposite of: **a** $+4$ **b** -9 ?

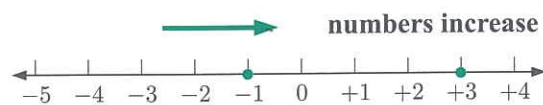
- a** The opposite of $+4$ is -4 .
b The opposite of -9 is $+9$.

Numbers which are **opposites** are the same distance from zero on the number line, but on different sides.



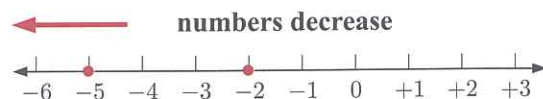
We can use a number line to compare the sizes of different numbers and arrange them in order.

As you move along the number line from *left to right*, the numbers increase. In a group of numbers, the number furthest to the right is the greatest number.



$+3$ is *greater* than -1 because it is further to the right on the number line.

As you move along the number line from *right to left*, the numbers decrease in size. In a group of numbers, the number furthest to the left is the least number.



-5 is *less* than -2 because it is further to the left on the number line.

We can use the symbols $>$ and $<$ when comparing numbers.

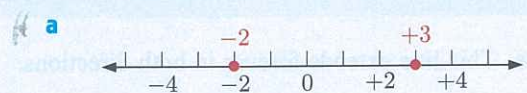
$>$ stands for 'is greater than'

$<$ stands for 'is less than'

So, we could write these two statements as $+3 > -1$ and $-5 < -2$.

Example 3**Self Tutor**

- a** Show $+3$ and -2 on a number line and write a sentence comparing their size.
b Write the statement $-7 > -4$ in words, then state whether it is true or false.



Since $+3$ is further to the right, $+3$ is greater than -2 .
 We could also say -2 is less than $+3$.

- b** The statement reads 'negative 7 is greater than negative 4'.
 This is false because -7 is to the **left** of -4 , and so it is less than -4 .

EXERCISE 3B

- Write the opposite of each number:
a -3 **b** 15 **c** -10 **d** -9 **e** 38 **f** -6 **g** $+7$ **h** 0
- Show -1 and -6 on a number line and write a sentence comparing their size.
- Write the statement $2 > -5$ in words, then state whether it is true or false.

- 4 Write *true* or *false* for each of the following statements:

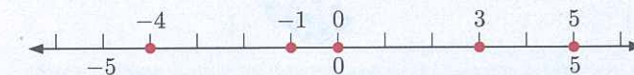
- a** $6 > 2$ **b** $-4 < 15$ **c** $17 > 18$
d $-2 < 19$ **e** $-13 > 5$ **f** $-20 < -12$

- 5 Insert either $<$ or $>$ in place of \square to make each statement true:

- a** $8 \square 6$ **b** $18 \square 7$ **c** $-9 \square -4$
d $-3 \square 15$ **e** $20 \square -15$ **f** $-6 \square -2$

Example 4**Self Tutor**

Locate the values of 5 , 3 , 0 , -1 , and -4 on a number line.



- 6 Draw number lines to show the following sets of numbers. Use a different number line for each set.

- a** $-9, 2, 5$ **b** $2, 6, 8, -3, -4$
c $9, -4, -9, 1, 6, -6$ **d** $-3, 2, 5, -5, 0, -1$

- 7 Display the number set $4, -2, 1, -1$ on a number line.

Hence arrange the numbers from least to greatest.

- 8 Display the number set $5, -3, 0, 2, -4, 6, -1$ on a number line.

Hence arrange the numbers from least to greatest.

- 9 **a** Arrange in descending order:

$0, -5, 8, -7, -2$, and 6 .

- b** Arrange in ascending order:

$0, -10, 8, 7, -7$, and -2 .

Descending means downwards. Ascending means upwards.



- 10 The temperatures of six cities were:

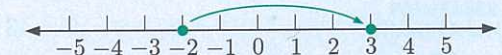
Ulaanbaatar 3°C , Singapore 33°C , Melbourne 19°C , Oslo -4°C , Moscow -6°C , Tokyo 1°C .

Place them in order from coldest to hottest.

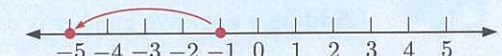
Example 5**Self Tutor**

Use a number line to: **a** increase -2 by 5 **b** decrease -1 by 4 .

- a** To *increase* -2 by 5 , we move along the number line 5 units to the *right*.
 The result is $+3$.



- b** To *decrease* -1 by 4 , we move along the number line 4 units to the *left*.
 The result is -5 .



11 Use a number line to:

- a increase -5 by 1 b decrease 3 by 4 c decrease -5 by 6
d increase -4 by 3 e increase -5 by 5 f decrease -1 by 6

12 Use a number line to find:

- a $3 + 7$ b $-3 + 5$ c $5 - 9$ d $4 - 8$
e $0 - 6$ f $-11 + 7$ g $-2 - 6$ h $-3 - 9$

ACTIVITY 1

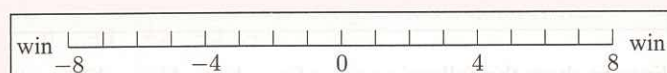
NUMBER GAME FOR 2 PLAYERS

You will need:

- 2 different coloured dice
- 2 counters
- a number line



PRINTABLE
NUMBER LINE



How to play:

- Choose one die to represent the positive numbers 1 to 6 and the other to represent the negative numbers -1 to -6 .
- Start the game with both counters on zero.
- Take it in turns to throw both dice and move your own counter according to the sum of the numbers thrown.
- Keep going until one player goes over either end. Their score must be greater than 8 or less than -8 . That person wins!

C

ADDING AND SUBTRACTING NEGATIVES

ADDING A NEGATIVE NUMBER

We know that $4 + 3 = 7$, but what is the value of $4 + -3$?

Consider the following true statements:

$$\begin{aligned} 4 + 3 &= 7 \\ 4 + 2 &= 6 \\ 4 + 1 &= 5 \\ 4 + 0 &= 4 \end{aligned}$$

As the number being added to 4 decreases by 1, the final answer also decreases by 1.

Continuing this pattern gives:

$4 + -1 = 3$	Compare with:	$4 - 1 = 3$
$4 + -2 = 2$		$4 - 2 = 2$
$4 + -3 = 1$		$4 - 3 = 1$
$4 + -4 = 0$		$4 - 4 = 0$

Adding a negative number is equivalent to subtracting its opposite.

For example, $2 + -6$ is equivalent to $2 - 6$.

SUBTRACTING A NEGATIVE NUMBER

We know that $4 - 3 = 1$, but what is the value of $4 - -3$?

Consider the following true statements:

$$\begin{aligned} 4 - 3 &= 1 \\ 4 - 2 &= 2 \\ 4 - 1 &= 3 \\ 4 - 0 &= 4 \end{aligned}$$

As the number being subtracted decreases by 1, the answer increases by 1.

Continuing this pattern gives:	$4 - -1 = 5$	Compare with:	$4 + 1 = 5$
	$4 - -2 = 6$		$4 + 2 = 6$
	$4 - -3 = 7$		$4 + 3 = 7$
	$4 - -4 = 8$		$4 + 4 = 8$

Subtracting a negative number is equivalent to adding its opposite.

For example, $3 - -5$ is equivalent to $3 + 5$.

Example 6

Self Tutor

Simplify and then evaluate:

a $2 + -5$	b $2 - -5$	c $-2 + -5$	d $-2 - -5$
$= 2 - 5$	$= 2 + 5$	$= -2 - 5$	$= -2 + 5$
$= -3$	$= 7$	$= -7$	$= 3$

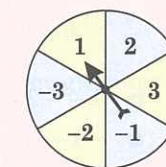
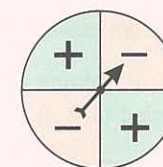
ACTIVITY 2

SHARKS

This Activity builds on from the Number game for 2 players on page 68.

You will need:

- 2 spinners
- 2 counters
- a number line



SHARKS | -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 | SAFETY



PRINTABLE
NUMBER LINE



How to play:

- Both players start at zero.
- One player spins the direction spinner.
If you spin a positive direction (+) you face towards the SAFETY end.
If you spin a negative direction (-) you face towards the SHARKS end.

- 3 The same player then spins the **steps** spinner.
If you spin a positive value, step **forward** the number of steps indicated.
If you spin a negative value, step **backward** the number of steps indicated.
- 4 Players take it in turns to move.
- 5 Keep playing until a player reaches either the SHARKS or SAFETY. If they reach the SHARKS, they lose. If they reach SAFETY, they win!

Discussion

What combinations of spins allow you to head to safety?

EXERCISE 3C

- 1 Simplify if possible, and then evaluate:
- a $4 - 3$ b $4 + 3$ c $-4 - 3$ d $-4 + 3$
e $4 + -3$ f $4 - -3$ g $-4 + -3$ h $-4 - -3$
- 2 Simplify if possible, and then evaluate:
- a $2 - 6$ b $2 + 6$ c $-2 - 6$ d $-2 + 6$
e $2 + -6$ f $2 - -6$ g $-2 + -6$ h $-2 - -6$
- 3 Evaluate:
- a $1 + -2$ b $-2 + -6$ c $6 + -8$ d $-3 - -7$
e $3 + -13$ f $4 - -5$ g $-7 - -10$ h $-9 + -8$
- 4 A maintenance man in an office block starts his working day on the ground floor. To fulfil his duties he goes up 12 floors, down 3 floors, up 5 floors, down 7 floors, up 1 floor, and then down 6 floors. What floor does he end up on?
- 5 Evaluate:
- a $-2 - 7$ b $-7 + 5$ c $-6 + -3$
d $-13 - 8$ e $-7 + -5$ f $-6 - -9$
g $2 + -12$ h $-4 - -3$ i $-11 - -17$
- 6 Simplify and hence evaluate:
- a $4 + 7 + -10$ b $8 - -2 + -4$ c $-4 - -6 - -1$
d $-12 - -9 + 5$ e $-4 - -5 + -8$ f $-3 - -10 + 10$
g $-3 - 7 + -7$ h $-10 + -8 + -9$ i $-1 + 10 - -7$
- 7 Find the difference between:
- a -5 and 4 b -2 and -5
c 8 and -1 d -4 and -2
e 8 and -8 f -7 and 8

The difference between two numbers is the greater number minus the lesser number.



- 8 Salt Lake City recorded the following maximum temperatures for a week:

Mon 5°C , Tues -3°C , Wed -7°C ,
Thurs 2°C , Fri 1°C , Sat -4°C ,
Sun -1°C .

What was the *average* daily maximum temperature for the week?

To find the *average*, add the 7 temperatures and then divide this sum by 7.

**ACTIVITY 3****MAGIC SQUARES**

4	3	8
9	5	1
2	7	6

A **magic square** is a square grid filled with **consecutive whole numbers** so that each row, column, and diagonal has the same sum.

For example, this magic square contains the numbers 1 to 9, and has the **magic sum** of 15 along every row, column, and diagonal.

What to do:

- 1 Copy and complete the following magic squares:

a

4		8
	7	
		10

b

		7	12
15		9	6
	5		
8	11	2	

- 2 Magic squares may also contain negative numbers.

- a Is the square alongside a magic square? If so, what is the magic sum?
- b Make a new magic square by adding 2 to each number in the magic square given. State the new magic sum.
- c Make a new magic square by subtracting 3 from each number in the magic square given. State the new magic sum.

2	-5	0
-3	-1	1
-2	3	-4

- 3 If 3 was added to each number in a 3×3 magic square, what would happen to the magic sum? Use your answers in 2 to help you.

- 4 Copy and complete the following magic squares:

a

-4		0
	-1	
		2

b

3			-9
-8			
-7		-4	5
6		-1	-6

c

4	11		-5	2
		-6	1	
-9	-7	0	7	
-3			8	
-2			-11	-4

D

MULTIPLYING NEGATIVE NUMBERS

We have already seen how to add and subtract negative numbers. In this Section we look for rules for their **multiplication**.

Consider the following true statements:

$$\begin{array}{l} 3 \times 3 = 9 \\ 3 \times 2 = 6 \\ 3 \times 1 = 3 \\ 3 \times 0 = 0 \end{array} \quad \begin{array}{l} -3 \\ -3 \\ -3 \\ -3 \end{array}$$

As the number being multiplied by 3 decreases by 1, the final answer decreases by 3.

Continuing this pattern gives:

$$\begin{array}{l} 3 \times -1 = -3 \\ 3 \times -2 = -6 \\ 3 \times -3 = -9 \end{array} \quad \begin{array}{l} -3 \\ -3 \\ -3 \end{array}$$

We can change the order in which numbers are multiplied, so we can also say that

$$\begin{array}{l} -1 \times 3 = -3 \\ -2 \times 3 = -6 \\ -3 \times 3 = -9 \end{array}$$

These suggest that **(positive) \times (negative) = (negative)** and **(negative) \times (positive) = (negative)**.

A similar pattern shows that:

$$\begin{array}{l} -3 \times 3 = -9 \\ -3 \times 2 = -6 \\ -3 \times 1 = -3 \\ -3 \times 0 = 0 \end{array} \quad \begin{array}{l} +3 \\ +3 \\ +3 \\ +3 \end{array}$$

As the number being multiplied by -3 decreases by 1, the final answer increases by 3.

Continuing this pattern gives:

$$\begin{array}{l} -3 \times -1 = 3 \\ -3 \times -2 = 6 \\ -3 \times -3 = 9 \end{array} \quad \begin{array}{l} +3 \\ +3 \\ +3 \end{array}$$

This suggests that **(negative) \times (negative) = (positive)**.

RULES FOR MULTIPLICATION

- **(positive) \times (positive) = (positive)**
- **(positive) \times (negative) = (negative)**
- **(negative) \times (positive) = (negative)**
- **(negative) \times (negative) = (positive)**

When the signs are the **same**,
the answer is **positive**.
When the signs are **different**,
the answer is **negative**.



Example 7



Evaluate:

a 2×5	b 2×-5	c -2×5	d -2×-5
a $2 \times 5 = 10$	b $2 \times -5 = -10$	c $-2 \times 5 = -10$	d $-2 \times -5 = 10$

EXERCISE 3D

1 Evaluate:

a 6×4	b 6×-4	c -6×4	d -6×-4
e 4×-6	f -4×6	g 4×6	h -4×-6

2 Evaluate:

a 3×-2	b -10×3	c -2×-7	d 5×-10
e -6×8	f 5×-9	g -8×11	h 3×-11
i 9×-9	j -12×-2	k 11×-5	l -6×-7

3 Determine the missing number in each of the following:

a $-2 \times \square = -2$	b $\square \times 5 = -10$	c $\square \times 1 = -11$
d $8 \times \square = -32$	e $-3 \times \square = 18$	f $8 \times \square = -16$
g $-2 \times \square = -8$	h $9 \times \square = -9$	i $\square \times -7 = -42$
j $\square \times -10 = 30$	k $4 \times \square = -12$	l $\square \times 12 = -120$

4 Solve the following questions:

- a** A skydiver falls 70 metres per second for 4 seconds. How many metres does he fall?
- b** When Tania bought a new bicycle for \$540, she borrowed the money from her parents. She repays them \$70 per week for 6 weeks. How much does Tania still owe her parents?



5 Evaluate:

a $-5 \times 8 \times 5$	b $-7 \times 3 \times -3$	c $-2 \times 5 \times -2$	d $(-3)^3$
e $-8 \times 5 \times -5$	f $(-2)^2$	g $-7 \times (-1)^2$	h $-2 \times 9 \times -5$
i $(-5)^3$	j -6×2^2	k $-8 \times 2 \times -3$	l $(-4)^2 \times 5$

6 Evaluate:

a $(-1)^2$	b $(-1)^4$	c $(-1)^5$	d $(-1)^7$	e $(-1)^{10}$
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What do you notice?

E

DIVIDING NEGATIVE NUMBERS

In this Section we look for rules for the **division** of negative numbers.

We know that $12 \div 4 = 3$, but how do we calculate:

- $12 \div -4$
- $-12 \div 4$
- $-12 \div -4$

The rules for division are identical to those for multiplication. This is not surprising because multiplication and division are **inverse operations**.

For example, \div by 2 is the same as \times by $\frac{1}{2}$.

RULES FOR DIVISION

(positive) \div (positive) = (positive)
 (positive) \div (negative) = (negative)
 (negative) \div (positive) = (negative)
 (negative) \div (negative) = (positive)

Example 8

Self Tutor

Evaluate:

a $-6 \div 2$

b $8 \div -4$

a $-6 \div 2 = -3$

b $8 \div -4 = -2$

Dividing numbers with the same signs gives a **positive**.
Dividing numbers with **different** signs gives a **negative**.



EXERCISE 3E

1 Evaluate:

a $15 \div 3$

b $15 \div -3$

c $-15 \div 3$

d $-15 \div -3$

e $45 \div 9$

f $-45 \div -9$

g $-45 \div 9$

h $45 \div -9$

i $6 \div 6$

j $6 \div -6$

k $-6 \div 6$

l $-6 \div -6$

m $44 \div 4$

n $-44 \div 4$

o $-44 \div -4$

p $44 \div -4$

2 Determine the missing number in each of the following:

a $12 \div \square = -3$

b $\square \div -2 = 3$

c $-4 \div \square = 1$

d $\square \div 5 = -5$

e $-18 \div \square = 2$

f $\square \div 4 = -3$

g $\square \div -2 = 4$

h $30 \div \square = -6$

i $\square \div -8 = 5$

j $36 \div \square = -4$

k $-15 \div \square = -5$

l $\square \div -4 = 7$

m $72 \div \square = -9$

n $\square \div 10 = -12$

o $\square \div -12 = -12$

p $-96 \div \square = -8$

3 Solve the following questions:

a A company owned equally by seven people has a debt of \$350 000. What is each person's share of the debt?

b One night in the Gobi Desert, the temperature drops from 33°C to -12°C in five hours. What is the average temperature change per hour?

The *average* temperature change is the total temperature change divided by the number of hours.



F

COMBINED OPERATIONS

The order of operations rules also apply to negative numbers.

- Brackets are evaluated first.
- Exponents are calculated next.
- Divisions and Multiplications are done next, in the order that they appear.
- Additions and Subtractions are then done, in the order that they appear.

Example 9

Self Tutor

Use the correct order of operations rules to calculate:

a $5 + -8 \times 3$

b $-5 - 15 \div -5$

$$\begin{aligned} \text{a } 5 + -8 \times 3 \\ &= 5 + -24 \quad \{\text{multiplication first}\} \\ &= 5 - 24 \quad \{\text{simplify}\} \\ &= -19 \end{aligned}$$

$$\begin{aligned} \text{b } -5 - 15 \div -5 \\ &= -5 - -3 \quad \{\text{division first}\} \\ &= -5 + 3 \quad \{\text{simplify}\} \\ &= -2 \end{aligned}$$

Remember to use BEDMAS!



EXERCISE 3F

1 Find, using the order of operations rules:

a $3 + 4 \div -2$

b $-1 + -3 \times 2$

c $8 \div -2 + 5$

d $-3 \times -2 - 4$

e $2 - 6 \div -3$

f $-2 \times 4 + -7$

g $7 - 3 \times -3$

h $-4 \times -5 - 12$

i $3 - 6 \div -6$

j $(-3 + 4) \times -7$

k $15 \div (4 - 7)$

l $-3 \times (-2 + 5)$

2 Do -3^2 and $(-3)^2$ have the same value? Explain your answer.

3 Min's company makes a \$100 000 profit per month for eight months, and then an \$80 000 loss for each of the next four months. Find her company's total profit or loss.

4 A computer store has the following sales record over a six-week period:

Week 1: \$388 profit Week 2: \$1373 loss Week 3: \$179 loss
Week 4: \$3013 profit Week 5: \$832 profit Week 6: \$1763 loss.

a What was the store's overall profit or loss for this period?

b What was the store's *average* weekly profit or loss during this period?

5 In indoor cricket, the person batting is penalised 5 runs for each wicket lost.

Josh lost 6 wickets, and scored 17 runs. What was his final score?



G

USING YOUR CALCULATOR

Calculators have a $\boxed{(-)}$ or $\boxed{+/-}$ key to specify a negative number.

On most calculators we press this key *before* the number, for example $\boxed{(-)} 2$.

On some older calculators, however, we press it *after* the number, for example $2 \boxed{+/-}$.

You will need to check what keys your calculator has and the sequence in which they need to be pressed.

Example 10

Self Tutor

Evaluate the following using your calculator:

a $-14 + -71$ **b** $22 - -45$ **c** $-8 \times -4 \div (7 - 11)$

Answers

a Press $\boxed{(-)} 14 \boxed{+} \boxed{(-)} 71 \boxed{ENTER}$

-85

or Press $14 \boxed{+/-} \boxed{+} 71 \boxed{+/-} \boxed{=}$

b Press $22 \boxed{-} \boxed{(-)} 45 \boxed{ENTER}$

67

c Press $\boxed{(-)} 8 \boxed{\times} \boxed{(-)} 4 \boxed{\div} \boxed{(} 7 \boxed{-} 11 \boxed{)} \boxed{ENTER}$

-8

EXERCISE 3G

1 Use your calculator to evaluate:

a $-35 + 61 - 47$ **b** $-26 - -41 + 38$ **c** $-92 - 16 + 57$
d $-12 - -87 - 129$ **e** 38×-25 **f** $-1280 \div 320$
g $-48 \div -12 \times -6$ **h** $-630 \times 8 \div -36$

2 In windy conditions a helicopter falls 30 m, rises 45 m, falls 20 m, rises 10 m, falls 15 m, then rises 12 m. How far is it now above or below its original position?

3 Regina has \$645 in the bank. She withdraws \$423, deposits \$371, deposits \$229, and then withdraws \$738. What is her new bank balance?

4 Abdul wanted to buy a nice car, so he saved €80 per week for 5 years. How much extra money did he need to borrow, to buy a car valued at €26 000?

5 Answer the questions in the Opening Problem on page 62.



KEY WORDS USED IN THIS CHAPTER

- addition
- integer
- negative number
- positive number
- division
- less than
- number line
- subtraction
- greater than
- multiplication
- opposite

REVIEW SET 3A

1 Use a number line to evaluate:

a $4 - 7$ **b** $-3 + 6$ **c** 3×-2 **d** -3×-4

2 **a** What must I divide 96 by to get -8 ?

b Copy and complete: negative \div positive =

c Insert $<$ or $>$ to make the following true: $-5 \square 3$.

3 State the combined effect of:

a borrowing 5 books and returning 2 **b** depositing \$78 and withdrawing \$88.

4 Evaluate:

a $5 - -3 + -7$ **b** $(-8)^2$ **c** $-20 + 15 \div -3$

5 **a** Arrange in ascending order: 2, -4 , 0, -3 , -6 , 7, 3.

b Find the difference between the greatest and least values in **a**.

6 **a** Use a number line to decrease 2 by 9.

b Insert $<$ or $>$ between 3 and -8 to make a true statement.

c Simplify $12 \times (-1)^3$.

7 Roger's business has \$12 500 in the bank. He must pay each of his 8 employees a wage of \$389 per week for 4 weeks. How much money will be remaining in the bank?

8 Write the opposite of:

a $+9^\circ\text{C}$ **b** -28 m **c** $+36 \text{ points}$

9 Which is the greater distance:

A rising from 77 m below sea level to 12 m above sea level, or

B falling from 409 m above sea level to 321 m above sea level?

10 Beck, Cathy, Emily, and Ying agreed to meet at a coffee shop. Beck was 9 minutes late, Cathy was 4 minutes early, Emily was 17 minutes late, and Ying was 10 minutes early.

a Who arrived first?

b Who arrived closest to the agreed time?

c Find the difference between the arrival times of:

i Beck and Ying **ii** Cathy and Emily

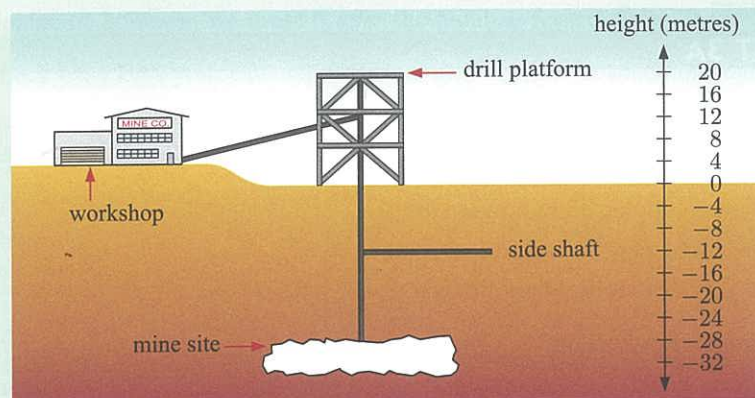
iii Beck and Emily.



- 11** In a mathematics competition, students are awarded 3 points for a right answer, and penalised 4 points for a wrong answer. Amy gave 6 wrong answers and 24 right answers. Sean gave 14 wrong answers and 16 right answers.

- How many points did each student score?
- By how many points did Amy beat Sean?

12

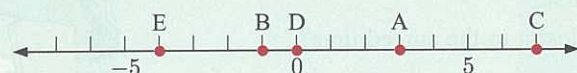


The illustration shows some important parts of a mine.

- State the level of:
 - the top of the drill platform
 - the bottom of the workshop
 - the side shaft
 - the top of the mine site.
 - How much higher is the drill platform than the side shaft?
 - How much lower is the mine site than the workshop?
 - Find the difference in height between the mine site and the drill platform.
- 13** In golf, a player's score is expressed relative to the *par* score for the course. For a par 72 course, a player who completes the course in 75 strokes receives a score of 3 over par, or +3. A player who takes 68 strokes receives a score of 4 under par, or -4.
- For a par 72 course, find the score for a player who completes the round in:
 - 70 strokes
 - 78 strokes
 - 67 strokes.
 - A tournament is played over 4 rounds.
 - Trevor shoots a score of -3 for each of the rounds. What is his score at the end of the tournament?
 - Wayne shoots scores of -5, +2, and -4 for the first 3 rounds. What score does he need in the final round to beat Trevor?

REVIEW SET 3B

- 1** Indicate the position of each point using a number:



- Copy and complete: negative \times negative =
- Evaluate -7×-11 .

- 3 a** Use a number line to increase -15 by 8.

b Hence evaluate $3 \times (-15 + 8)$.

- 4** Evaluate:

a $(-1)^5$

b $-12 \div 4 + 13$

c $-2 \times -3 \times -4$

- 5 a** Arrange in descending order: 5, -4, 0, 1, -1, 3, -6.

b Find the difference between the largest and smallest values.

c Find the sum of the numbers in **a**.

- 6** Greg wants to lose 12 kg. He initially loses 5 kg, then gains 1 kg per week for 3 weeks, then loses 2 kg.

a Find Greg's overall weight loss or gain.

b How much weight must Greg now lose to reach his goal?

- 7** If ground level is marked as 0 and the top of a 15 m high oil rig is assigned the integer 15, what integer would be assigned to:

a the top of a 2 m high boundary fence

b the bottom of a mine shaft 129 m below ground level

c the top of a truck 4 m tall?

- 8** The minimum temperatures for a week in Beijing were: -5°C , -4°C , -5°C , 2°C , 3°C , 3°C , -1°C .

Calculate the average minimum temperature for that week.

- 9** A warehouse contains 24 pianos. Each week 3 more are sent to the warehouse from the factory. Over a 4 week period, 1, 6, 3, and 5 pianos are sold. How many pianos are now in the warehouse?



- 10** A new office building has two lifts. There are two floors of underground carparking, and 9 floors above ground. The lifts can move up and down by 1 floor every 5 seconds.

a Lift 1 is on floor 7 and lift 2 is at B1. How far are the lifts apart?

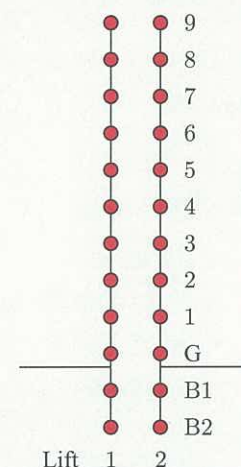
b Lift 1 moves down for 15 seconds. Where is it now?

c Lift 2 moves up for 25 seconds. Where is it now?

d Suppose the lifts are both at floor 3. Lift 1 starts moving up at the same time as lift 2 starts moving down.

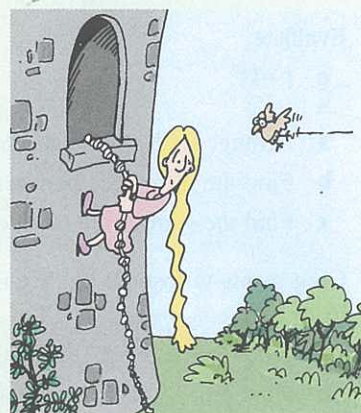
i Write an expression for the distance between the lifts after 10 seconds.

ii Will lift 1 reach the top floor before lift 2 reaches the bottom floor?

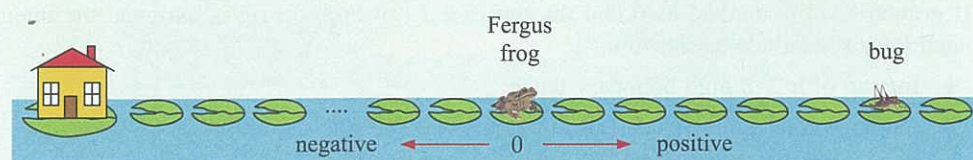


- 11** Previous experience has taught Rapunzel that using one's hair to escape is a bad idea. She instead knots bedsheets together, keeping the knots at equal intervals. From her window to the ground is a distance of 25 knots.

- a** If her window is 0, what number represents the ground?
- b** A climbing plant on the side of the tower reaches 11 knots up from the ground. What number represents the top of the plant?
- c** Rapunzel starts the climb at her window. She climbs down at the rate of 3 knots a minute.
 - i** What is her position after 4 minutes?
 - ii** How far above or below the top of the plant is she?



12



Fergus the Frog is on the lily pad at 0. He has spied a bug which he would like for dinner.

- a** Write down a number to represent the position of the bug.
- b** Fergus has forgotten his bow tie for dinner. He jumps back to his house, 2 lily pads at a time. If Fergus makes 4 jumps, what is the position of his house?
- c** Meanwhile, the bug has moved one lily pad to the right for each of Fergus' jumps. How far away is the bug now from 0?
- d** Not wanting to miss his dinner, Fergus chases after the bug. He jumps forward 3 lily pads every time, with the bug fleeing one lily pad for each of Fergus' jumps. How many jumps does Fergus need to catch the bug?

Chapter

4

Properties of numbers

Contents:

- A** Divisibility
- B** Factors
- C** Multiples
- D** Prime and composite numbers
- E** Roots

